Fine-Grained Tungsten Claddings for Cermet Based NTP Systems

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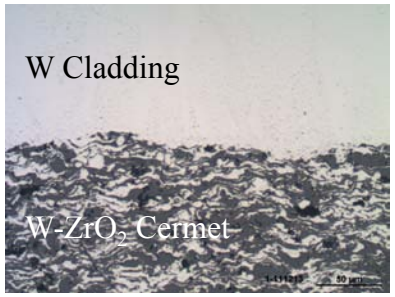
Identification and Significance of Innovation

- NASA's NCPS program is evaluating the affordability of NTP systems. A critical aspect of the program is to develop a robust, stable nuclear fuel such as cermets comprised of uranium dioxide (UO_2) particles encased in a tungsten matrix (W).
- Improved claddings are needed to prevent excessive fuel loss from reaction with the hot hydrogen gas and uranium hydride formation.
- During this effort, advanced additive manufacturing techniques are being developed to produce fine-grained, hermetic tungsten claddings for cermet based nuclear fuel elements.
- **TRL at the conclusion of Phase I: 3**



(Left) – Four VPS W claddings produced during the Phase I investigation. These samples were delivered to MSFC for testing in CFEET.
(Right) – Micrograph showing EL-Form® W cladding on W-ZrO2 cermet. Note the good bond between the W cladding and the cermet.

Phase I Research Results

- Phase I demonstrated the feasibility to produce fine-grained W claddings using EL-Form® and VPS processing techniques.
- Both techniques were suitable for producing W claddings on preformed W-oxide based cermets.
- Testing showed good bonds were produced between the Phase I W claddings and surrogate fuel rod materials, i.e., >10ksi.
- No signs of degradation were detected in the W claddings as a result of high temperature exposures and thermal cycling.
- Leak testing showed the W claddings had a leak rate of better than $1x10^{-7}$ cm^3/s of helium, i.e., the samples were vacuum tight.
- Samples were produced for delivery to NASA-MSFC for the fabrication of 7 channel fuel rods for compatibility testing of different cermet materials.

NASA and Non-NASA Applications

- NASA applications include Nuclear Thermal Propulsion (NTP) and Nuclear Electric Propulsion (NEP). Currently, NASA's Nuclear Cryogenic Propulsion Stage (NCPS) project is working to demonstrate the viability and affordability of NTP.
- Commercial applications include propulsion, nuclear industries, high temperature furnaces, corrosion resistant containment cartridges, crucibles for glass/advanced ceramic processing, heat pipes, thermal protection systems, and joining of refractory metals to advanced ceramic material.

Firm Contacts

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